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Enough? The role of sufficiency in European energy and climate plans

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ABSTRACT

Energy sufficiency is one of the three energy sustainability strategies, next to energy efficiency and renewable energies. We analyse to what extent European governments follow this strategy, by conducting a systematic document analysis of all available European National Energy and Climate Plans (NECPs) and Long-Term Strategies (LTSs). We collect and categorise a total of 230 sufficiency-related policy measures, finding large differences between countries. We find most sufficiency policies in the transport sector, when classifying also modal shift policies to change the service quality of transport as sufficiency policies. Types of sufficiency policy instruments vary considerably from sector to sector, for instance the focus on financial incentives and fiscal instruments in the mobility sector, information in the building sector, and financial incentive/tax instruments in cross-sectoral application. Regulatory instruments currently play a minor role for sufficiency policy in the national energy and climate plans of EU member states. Similar to energy efficiency in recent decades, sufficiency still largely referred to as micro-level individual behaviour change or necessary exogenous trends that will need to take place. It is not treated yet as a genuine field of policy action to provide the necessary framework for enabling societal change.

1. Introduction

In the pursuit of achieving the climate targets of the Paris Agreement, the European Union has presented scenarios for decarbonisation by 2050 (EC, 2019a) and has committed itself to the binding target of a minimum 40 % greenhouse gas emission reduction by 2030 (EC and Council of the European Union, 2018), which the EU-Commission intends to raise to 50–55 % in its draft Climate Law under the European Green Deal (EC, 2020d). An important policy mechanism in the context of the EU climate ambition is the commitment of EU member states to develop a vision for 2050 with national Long-Term Strategies (LTS) and a short-term implementation roadmap for 2030 with National Energy and Climate Plans (NECP).

The basic motivation behind this process is to lay the foundations for a successful "clean energy transition" and to play a key role in ensuring that member states join forces to move forward together towards the 2030 and 2050 goals. According to EC (2019b), they should provide clarity and predictability to stimulate necessary investments and facilitate the programming of Member State investment. While the Long-Term Strategies cover the long-term perspective of at least 30 years, the NECPs mainly cover ten-year periods including updates within this period. The final NECPs for this decade (2020–2030) had to be submitted by December 2019 and the LTS by January 2020. Most NECPs are available, while several LTS are delayed. For an up-to-date overview, see EC (2020c,b).

The reporting schedule of NECPs is synchronised with the reporting cycles of the Paris Agreement and the UNFCCC. In addition to providing an overview of the current energy system and policy situation, they formulate national objectives for the five dimensions of the Energy Union, namely Decarbonisation (including a section on renewable energy), Energy Efficiency, Energy Security, Internal Energy Market, Research & Innovation and Competitiveness (EC and Council of the European Union, 2018). On this basis, the member states describe current and planned policies and measures to meet these objectives.

Although there are several evaluations available for the NECPs and LTSs, they mainly focus on the adequacy of the plans to make their

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contribution to the European climate goals (EC, 2019b, 2020a), their suitability to lead to net zero emission economies (Duwe et al., 2019) or other key issues related to climate ambition including improvements to climate and energy targets, improvements to policies and measures, developments regarding coal phase-out, or commitments and improvements related to fossil fuel subsidies (CAN and ZERO, 2020). There are also more specific analyses, such as on the energy efficiency portfolios of the NECPs (Gkonis et al., 2020). A systematic analysis of sufficiency elements in NECPs and LTSs had not yet been carried out.

Based on the hypothesis that an EU pathway to 2050 net zero emissions relying predominantly on the technical options of efficiency and consistency would be difficult – if not impossible (for an elaboration of hypotheses see subsection 2.1) – and that energy sufficiency policies are necessary, the objective of this paper is to evaluate the current state of sufficiency measures in European climate and energy policies. To this end, we systematically analyse all available NECPs and LTSs of EU Member States. As these reports have a common structure and summarise current and planned energy and climate policies of all EU countries, they are suitable starting points for analysing our key questions: (1) whether sufficiency plays an explicit or implicit role at all in national energy and climate strategies, (2) which countries stand out in this respect, (3) which sectors include most/least (designated) sufficiency measures, (4) which types of sufficiency measures are dominating, and (5) which types of policy instruments are used or planned to be used to implement those sufficiency measures. Based on this analysis, we derive policy implications for the respective countries, but also for EU policy.

This paper is structured as follows: After providing our definition of sufficiency (measures) in the introduction and explaining our analysis method (section 3), we summarise the findings about sufficiency measures and targets and discuss our findings in section 4. The tables with the data for our analysis are provided as supplementary material. In section 5, we discuss the suitability of our method, limitations of the research and assess the validity of our findings. Finally, we derive policy implications based on the level and kind of sufficiency we found – on country, but also on EU levels (section 6).

2. Background and concept: energy sufficiency

2.1. Three interlinked strategies: renewable energies, efficiency, sufficiency

The importance of profound societal transformations for achieving the Paris Agreement objective is increasingly recognised, and there is a need to examine the values, ethics, attitudes and behaviours that underpin societies (IPCC, 2018; Toulouse et al., 2019). Beyond technological efficiency and the development of renewable energies (more general *closing material and energy loops*[1]), sufficiency is the strategy that aims at achieving absolute reductions in the use of energy-based services through societal and lifestyle changes. Hence, sufficiency policy tends to solve sustainability issues in a more systematic and multidimensional way by questioning e.g. mental structures, social norms or the economic system and thus exceeds classical energy policies by far. The scientific literature on sufficiency and in particular energy sufficiency is growing (see e.g. Darby (2007); Shove (2018); Samadi et al. (2017); Fawcett and Darby (2019); Thomas et al. (2019); Lorek and Spangenberg (2019); Sorrell et al. (2020); Vadovics and Živčič (2019); Moser et al. (2015); Sandberg (2021)). Sorrell et al. (2020) traces the history and semantics of the *energy sufficiency* concept and supplements it with an analytical critique arguing that there are various rebound effects in sufficiency. A recent debate also discusses implications and boundaries of sufficiency in developing country contexts (Monyei et al., 2018, 2019; Todd et al., 2019), also assessing inequality issues and links of final energy footprints to well-being (Baltruszewicz et al., 2021).

Absolute demand reduction due to behavioural changes is also reflected in climate and energy scenarios, sometimes explicitly (Purr et al., 2019; Toulouse et al., 2017; Brugger et al., 2021), sometimes hidden in assumptions on economic development or activity levels (e.g. Zell-Ziegler and Förster (2018); Samadi et al. (2017); Purr et al. (2019)). Consequently, attention to the importance of sufficiency for reaching climate goals is increasing. However, in political discourses sufficiency is often reduced to the moral responsibility of individuals (Spangenberg and Lorek, 2019) and therefore seldom supported by policy measures that enable, facilitate or even force sufficient behaviour (Thomas et al., 2019). As a result, the likelihood of reaching such pathways remains questionable (Lorek and Spangenberg, 2019).

2.2. Definition

The existing literature on energy sufficiency is based on various understandings of the concept and consequently there is no congruent definition of the term *energy sufficiency*.

Definitions vary for example according to whether they only take into account changes in behaviour and society, or also technical innovations, whether they regard sufficiency as a process (change) (Fischer et al., 2013), or also as a state (level), whether sufficiency is only a matter of reduction or also a shift towards more sustainability (most authors agree). There are different views on whether there are not only upper limits but also lower limits of "enoughness" that need to be met for being considered as sufficient (see e.g. Spengler, 2016; Raworth, 2017; Fawcett and Darby, 2019). Qualitative analyses assess the barriers to sufficiency, but also find that sufficiency can be accompanied by an increase in well-being (Sahakian, 2019). Furthermore, there is a growing literature discussing the connection of enoughness in energy and well-being including quantitative modelling approaches (Millward-Hopkins et al., 2020). While there is still no full conceptual consensus in the literature (see e.g. Sorrell et al., 2020), definitions increasingly converge towards the idea that energy sufficiency is the strategy of achieving absolute reductions of the amount of energy-based services consumed, notably through promoting intrinsically low-energy activities, to reach a level of enoughness that ensures sustainability.

With regard to the literature, we assume a broad understanding of sufficiency in order to capture all important policies and measures, aiming for a synthesis of existing sufficiency understandings.[2] Next to efficiency and renewable energies, we understand sufficiency as one strategy for achieving sustainability and climate targets. Sufficiency in general aims at a level of "enoughness" with a view to avoiding excess, in particular with regard to ecosystem capacity while ensuring a good life (Fawcett and Darby, 2019). Energy sufficiency reduces energy consumption by limiting the use of energy services by reducing utility units of energy services (e. g. m^2 heated or person-km driven), or by changing aspects of the quality of energy services and favouring alternative services that require no or very little energy (e.g. cycling instead of driving). We term the latter *substitution*. Sufficiency requires changes in current mainstream behaviours, social practices and norms, and the organisation of society (such as spatial planning, dominant socio-economic paradigm, etc.).[3]

[1] Closing energy loops in the energy sector describes the development of renewable energies.

[2] Three categories of sufficiency understandings can be distinguished: (1) individual demand reduction (Sorrell et al., 2020; Stengel, 2011), (2) sufficiency as a post-growth strategy, which recognises cultural drivers of growth (Schneidewind and Zahrnt, 2014) and (3) sufficiency as an emancipatory transformation strategy, which aims at comprehensive social-ecological and political justice (von Winterfeld, 2017).

[3] For a discussion of the difficulties in defining *energy services*, utility units and inclusion/exclusion of only direct or also indirect energy consumption see Sorrell et al. (2020).

The texts of country reports on energy and climate policies are sometimes vague about the strategies they pursue making it difficult to evaluate their sufficiency content. We therefore take into account all policies that may include sufficiency measures and we include all policy measures from the documents that are expected to reduce absolute energy (service) demand levels, and to significantly change utility aspects. In addition, we include cross-sectoral measures that we expect may be able to support sufficiency action in a broader sense. Such measures set the general framework to support energy conservation measures through efficiency or sufficiency. The following section 3 outlines our approach to categorise measures.

3. Methods

3.1. Analysis base: NECPs and LTSs

The basis of our analysis are official documents available from the websites of the European Commission (NECPs: EC (2020c), LTSs: EC (2020b)). Delayed documents were also analysed if available by October 2020 (with the only exception of Finland (FI), where documents were only available in the national language and translation was not possible). We analysed versions in their original national language if the authors were able to, otherwise the analysis referred to the submitted English versions. Where no English version was available, we used software such as DeepL to translate the reports into English (Translations are available from the corresponding author). The main analysis of this paper builds on text content analysis, only the keyword analysis in subsection 3.2 is a more simple mechanistic keyword counting. As all contents were analysed by two peer coders (see below), and some both in original and translated language, with results conciled between coders, we assume linguistic bias to be limited. In total, we cover 27 NECPs (UK as former EU member did not submit a report) and 15 LTSs, see Table 1. It has to be noted that NECPs and LTSs were prepared by EU Member States mainly in 2019/2020 and therefore describe the energy and climate policies implemented or planned at that time. The current dynamics within climate policy – which leads to more ambitious climate targets – is not yet reflected in those reports for most of the countries.

Table 1
Overview of NECPs and LTSs that were considered in the analysis.

Country	NECP	LTS
Austria	x	x
Belgium	x	x
Bulgaria	x	
Croatia	x	
Cyprus	x	
Czechia	x	x
Denmark	x	x
Estonia	x	x
Finland	x	
France	x	x
Germany	x	x
Greece	x	x
Hungary	x	x
Ireland	x	
Italy	x	
Latvia	x	x
Lithuania	x	x
Luxembourg	x	
Malta	x	
Netherlands	x	x
Poland	x	
Portugal	x	x
Romania	x	
Slovakia	x	x
Slovenia	x	
Spain	x	
Sweden	x	x
United Kingdom		
TOTAL	27	15

3.2. Screening of "sufficiency" references

The preliminary analysis included a screening of whether NECP/LTS documents refer to the term *sufficiency* (or an equivalent term in national language) and the term *sufficient* in the sense as defined above. Such references were counted for each NECP/LTS document. Other meanings of the terms like "self-sufficiency" or "sufficient generation capacities" were not counted.

3.3. Proceeding of sufficiency measure extraction

We extracted all sufficiency-related measures from the documents. Only measures that either already exist or are planned were collected, excluding measures that have expired. Visions (especially from LTS) are included when referring to concrete policy measures. We relate the term vision to long-term, farsighted ideas or targets, that are not concretely formulated as plans or strategies. We clustered the encountered measures by the sectors mobility/transport, buildings, agriculture/nutrition, consumption/production and cross-sectoral. Measures within the sector land use/LULUCF are excluded. In NECPs we reviewed in particular summary tables of measures (where available) and the chapters on policies and measures focusing on the chapters on the dimensions decarbonisation and energy efficiency. LTSs have no such common structure. We therefore screened all chapters and searched the document for key terms. Certain chapters were possible to exclude for a sufficiency measure collection, when they were clearly dedicated to pure efficiency or renewable energy policies.

For this collection we excluded measures that do not meet our sufficiency definition as described in section 1 (e.g. electric vehicle market ramp-up, building renovation for matching thermal comfort, or organic farming). In turn, we included all measures related in any way to sufficiency; whether explicitly referred to as 'sufficiency', clearly targeted at reducing service demand, or 'just' altering the general framework, thus potentially supporting sufficiency, efficiency and renewable energies (consistency) together.

As any sufficiency scholar knows, the boundaries between sufficiency, efficiency and consistency are not always perfectly drawn (Toulouse, 2020). This attribution question arises for measures that involve a significant reduction of an energy-intensive behaviour or service (e.g. of fossil-fuel car driving) through substitution by a more sustainable behaviour with a non-negligible energy demand (e.g. public transport). This hybrid of a clear sufficiency-related measure with a consistency or efficiency measure applies to various types of transport mode shift and dietary change. We have therefore developed three types of sufficiency to categorise measures and gain a better overview on their effects and possible impact. In the following, we give examples of our coding procedure.

3.4. Categorisation of measures by sufficiency type

Among the policy measures to be found in the documents, we identified sufficiency measures aimed at reducing energy service levels (and sometimes explicitly termed as such), measures aimed at reducing certain demands but at the cost of shifting (part of the) demand to other still energy-based means/services, and others that improve the general framework supporting any energy savings irrespective of their nature, either in a specific sector or across sectors. We thus developed a three-class categorisation of the measures according to their sufficiency-relatedness. Common to all these measures is that they target environmental sustainability through energy or emission reductions, and all involve to some extent a reduction in certain energy services and to some extent also substitution. We distinguish the types of measures in

terms of how sufficiency is to be achieved:

- **Reduction**: Measures aimed at reducing energy services (such as distance travelled, heated m^2) or explicitly mentioning sufficiency (in supplementary material coded as "2")
- **Substitution**: Measures aimed at reducing the use of certain energy-intensive services by replacing them with less energy-intensive services, implying changes in social and behavioural practices (e.g. shifting from individual motorised transport to public transport; coded as "1")
- **General**: Measures that alter the regulatory or incentive framework to promote reduction of GHG-emissions in general (e.g. taxation structure). Strategies could either be sufficiency, efficiency or consistency (e.g. shift to renewable energies), the actual effects of the measures are not yet foreseeable (coded as "0").

The distinction between reduction and substitution measures follows Sorrell's (2020, p.4) conceptual distinction of "restraint versus substitution" actions (without Sorrell's limitation to voluntary action), translates this into policies promoting such actions, and is complemented by the third category of more general measures. Other differentiations of sufficiency types are possible, for instance in terms of the character of perceived change (Sachs, 1993) or four levels of "perceived restraint or effort" (Fischer et al., 2013, p.11), or more elaborated subcategorisations of sufficiency measures (e.g. "Reducing", "Substituting", "Better sizing", "Sharing", etc.), as proposed by Toulouse et al. (2019) and similarly used by Sandberg (2021). We consider our simpler approach as parsimonious and already sufficiently differentiated for this analysis. Table 2 illustrates exemplary measures and our respective coding in the database.

Measures aimed at improving transport efficiency or shifting from internal combustion engines to alternative fuels (electricity, gas, other) or at promoting car sharing are not aimed at reducing individual motorised transport and are thus not considered in this analysis as sufficiency measures but as efficiency measure and consequently not included in the measures list.[4]

To characterise and describe the sufficiency measures further, we extracted, where possible, information from the reports on the sector and the instrument type (see subsection below).

3.5. Categorisation of measures by instrument type

We categorised the encountered measures by seven policy instrument types according to UNFCCC (2000). The additional "other" category mainly includes plans and strategies but also other specified measures e.g. in the field of digitalisation that did not fit into other categories. We also added an additional ninth category "not specified" for descriptions of sufficiency measures without any hint on the instrument type or a further specification of the measure. Measures can include one or multiple instrument types.

1. Economic (e.g. taxes, tradable certificates, market reform),
2. Fiscal (e.g. subsidies and grants, tax exemptions and public expenditures for infrastructure),
3. Voluntary agreements,
4. Regulation (laws, standards and product identification),
5. Information,
6. Education (institutional),
7. Research and development,
8. Other (e.g. plans)
9. Not specified

[4] We highlight, that the literature has not concluded on definitions and many researchers *would* consider and define sharing options as a sufficiency category (see e.g. Toulouse et al., 2019).

3.6. Assuring categorisation consistency

As the analysis of all European NECPs and LTSs involved the screening of all available documents for all EU27 member states - and documents often encompass several hundred pages - screening and coding work was shared between co-authors. The above described measure extraction and categorisation approach indicates a number of not entirely clear-cut coding rules where coders might take diverging coding routes. Possible bias may occur with:

- screening and including measures (number of measures)
- sufficiency type categorisation (reduction/substitution/general)
- instrument type categorisation (according to UNFCCC, 2000).

In order to minimise the introduction of coding bias, we proceeded as follows to ensure inter-coder validity and consistency of the analysis:

- assignation of analyst/coder to country
- screening of NECP/LTS, extraction of policy measures into database, coding: categorisation by sector, sufficiency type and instrument type
- (random) assignation of peer analyst/reviewer by country
- second-round analysis, measure extraction and coding by blind peer-author
- comparison and discussion of findings/inconsistencies between coders
- by-country consolidation of findings between authors.

First-round analysis yielded 186 measures, in the second round 255, with a total consolidated number of 230 sufficiency measures found in the documents. Differences in by-country analyses in some cases varied substantially in the second vs. first round from -9 (CY) to +11 (PT), mostly owed to the inter-coder variation in distinguishing single measures in the source documents or merging sub-measures to one measure. In regular coder meetings, a common understanding for coding was elaborated whenever questions arose. In the consolidation phase, the two respective coders implemented the common understanding in the categorisation to ensure comparability of policy measures across countries. Case by case, all encountered measures were compared and consolidated to include all measures found by individual coders, to exclude measures not fitting the definition and to ensure sufficiency type and instrument type coding consistency. Where codings were inconsistent, we revised the primary resources (NECP/LTS) to agree on the categorisation.

4. Results and discussion

4.1. Keyword analysis

The keyword *sufficiency* is only mentioned in the NECPs of two countries: France (four times) and Germany (once) as well as in the LTSs of two countries: Again France (18 times) and Austria (once). The keyword *sufficient* is only used in relation to self-sufficiency or other developments being "sufficient" and thus not in the sense of our sufficiency definition. This analysis leads to at least two conclusions: Firstly, the fact that the term sufficiency is – in most countries – not used in the official communication on climate mitigation might result from the lack of this term within the political and societal debate on sustainability strategies and its lack in the provided reporting templates. Secondly, the frequent – and in comparison to other countries prevalent – use of the term sufficiency in the French documents illustrates that public discussions and activities related to sufficiency seem more widespread in France than in other countries. In cases such as Austria, documents include substantial sufficiency-inspired measures but do not mention the term at all. We therefore look into these exemplary cases with more detail (see section 4.3).

Table 2
Exemplary sample for extracted measures coding in the database.

Sector	Measure example	Suf. type	Explanation sufficiency type categorisation
Buildings	households/enterprises: energy savings audits if behavioural change explicitly mentioned	0	sufficiency is (most likely) included in the consultation but the actual changes after the consultation are unclear
	measures to increase co-living-concepts that reduce the privately used area	1	measures do most likely not lead to an absolute reduction of used area but a substitution, e.g. through the increase of other used area
	measures to reduce per capita living/heated area	2	measures aim at an absolute reduction
Mobility	measures that make unsustainable modes of transportation more expensive/sustainable modes cheaper	0	incentive for sufficiency provided but sufficiency is not necessary the consequence
	measures that ban private cars from certain areas in favour of more sustainable mobility	1	measures aim at travelling from A to B in a more sustainable manner but not at an absolute reduction in travelled km
	modal shift measures (e.g. promotion of public transport, cycling, related infrastructure)	1	measures aim at travelling from A to B in a more sustainable manner but not at an absolute reduction in travelled km
	freight modal shift to rail or waterways (from road/air)	1	measures aim at transporting goods in a more sustainable manner but not at an absolute reduction of goods transport
	measures that increase teleworking	2	measures aim at an absolute reduction in travelled km
	measures leading to shorter travel distances like smart city planning	2	measures aim at an absolute reduction in travelled km
Production/ Consumption	energy saving networks or agreements	0	could be sufficiency but also efficiency; the actual changes are unclear
	measures to reduce packaging material in supermarkets so that consumers have to bring their own	1	measures do not lead to an absolute reduction of resources but a substitution
	measures increasing repairability and/or the life-time of products	2	longer product life-times mean less products sold and less ressource inputs needed
Agriculture/ Nutrition	information campaigns on sustainable food consumption	0	the actual behavioural changes through the campaigns are unclear
	reduction of meat consumption/incentives for plant-based diet	1	measures aim at a less GHG-intensive food consumption but not at an absolute reduction of food
	reduction of food waste	2	reduction of food waste leads to an absolute reduction of food demand and therefore also food production
Cross-sectoral	awareness campaigns (e.g. on energy saving)	0	the actual behavioural changes through the campaigns are unclear
	energy and CO2 taxes	0	measures might lead to reduction of energy consumption but not necessarily

4.2. Findings by countries

In the 27 available NECP and 15 LTS documents, we found a total of 230 sufficiency-related policy measures. This includes the measures of all sufficiency types (see 3.4) in case they include at least one policy instrument (see 3.5). The number of measures ranges from 3 (RO) to 22 (DE), with most countries having described around 5 to 10 measures (see Fig. 1). These results show that sufficiency does play a greater role in some countries than in others. However, as mentioned in section 3, discrepancies also result from the fact that twelve of the analysed countries did only submit a NECP and no LTS. Furthermore, the structure and level of detail of individual documents can determine to some extent how many sufficiency measures could be identified and differentiated from one another: If countries explicitly mentioned separate

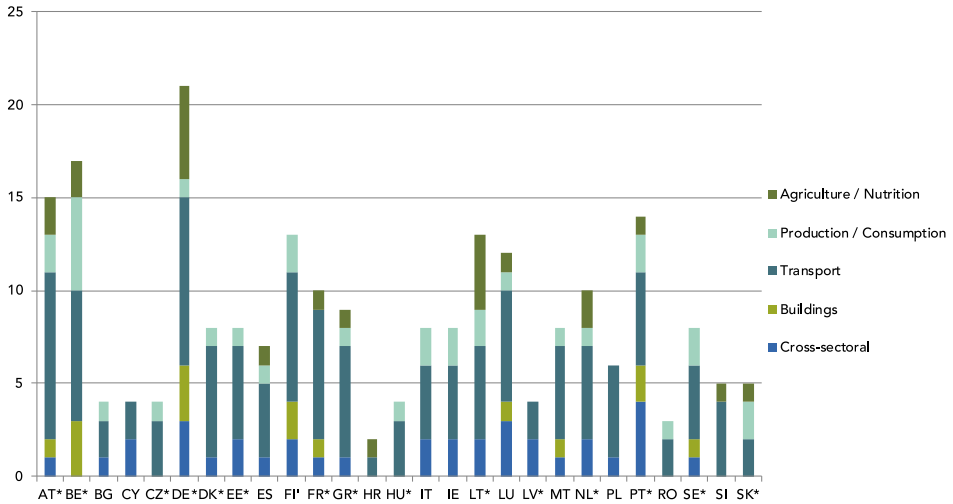

Fig. 1. Number of sufficiency measures by country and sector (all sufficiency types). Note: UK as former EU member state did not submit a NECP nor a LTS; * indicates a submission of both a NECP and a LTS;' Finland submitted both documents, but due to the delay of the LTS and availability only in national language, this could not be considered.

policy measures, these were taken up in our database. If countries did not explicitly mention measures but only vaguely refer to positions or needs, this could not be classified as measure. While collected numbers indicate the level of sufficiency-related policy orientation, they might not be fully reliable when comparing the level of sufficiency between countries. One clear finding of our research is that most sufficiency measures can be found in the transport sector.

We find two countries of special interest to energy sufficiency analysis. In France, the term *sufficiency* is mentioned exceptionally frequently: four times in the NECP and 18 times in the LTS. However, this linguistic emphasis does not (yet) seem to be translated into concrete policies. In Austria in turn, sufficiency is not mentioned at all in the NECP and only once in the LTS, however we found a broad set of sufficiency-guided policies. We thus asked country-experts to analyse and explain discrepancies between linguistic sufficiency mentions and content-wise sufficiency orientations in listed measures (see subsections below).

4.3. Country cases: France and Austria

France: Sufficiency has become an increasingly popular concept in the French public debate since the 2000's and the publication of a sufficiency-based energy transition scenario by the non profit energy think tank négaWatt (2020). The scenario is a reference for most national environmental NGOs and was actively promoted in national energy debates. The term *sobriété* entered legislation for the first time in 2015 with an Energy Transition Bill highlighting "energy efficiency and sufficiency", although no specific sufficiency policy measures were defined (Loi 992, 2015). When preparing the national LTS several years later, the authorities realised the difficulty of reaching carbon neutrality with only efficiency and renewables. After consulting stakeholders and experts, they included some sufficiency assumptions and trends in the energy scenario underpinning the LTS (e.g. behavioural change in the residential sector, a moderation of the growth of mobility needs, a reduction of meat consumption, etc.). These are qualified as a "reasonable" consideration for sufficiency and remain relatively moderate. They do not entail profound or systemic societal transformation (Toulouse, 2020). Yet, they have given credit to the concept: In an attempt at translating the LTS into more qualitative narratives and lifestyle illustrations coproduced by the Ministry of Environment, sufficiency is highlighted as one of the 21 main themes and mentioned again 50 times (Conseil national de la transition écologique, 2020).

In terms of actual policies, after a few noticeable sufficiency measures in the past, such as a ban of office and shop lighting after 1 a.m. decided in 2012 (Davies, 2013), it is only recently (after the elaboration of the NECP/LTS) that policy ideas inspired by sufficiency have been considered by the government. They are not necessarily the result from a well-defined and consistent long-term sufficiency plan, but often inspired from other initiatives, e.g. a Citizen's convention on climate change which proposed 149 policy measures, including sufficiency ones (Convention Citoyenne, 2020). The French President announced that he would consider most of these proposals (Gouvernement and Citoyenne (2020); Willsher (2020); Fekih (2020)). However, the governmental and legislative process to implement them often led to a reduction in scope, ambition, and pace compared to the original proposals (Haut Conseil pour le Climat, 2021). Two illustrations: the restriction of advertisement for highly-polluting goods, which was supposed to cover a wide-range of products (such as SUVs), has been limited to fossil fuel suppliers; the ban of short distance flights will only be implemented when trains can make it in less than 2.5 h, instead of 4 h originally (thus concerning a small share of domestic flights). This shows that, although a representative group of 150 French citizens endorsed and recommended bold sufficiency measures to tackle global warming, decision-makers are still largely reluctant to follow.

Austria: Various Austrian ministries organised a series of four major conferences between 2010 and 2018 entitled "Growth in Transition" (BMK, 2020), gathering academics and stakeholders to learn from and discuss national and international best practice cases of technological and social innovations and sufficiency measures. In these events, the topic of "sufficiency" played an important role in the discourse between civil servants and scientists. Also government programs such as "Mobility of the Future" (FFG, 2020b) and "House of the Future" (FFG, 2020a; Holler, 2020) for many years funded research on efficiency, innovation as well as sufficiency measures. Research reports used the term, but sufficiency has not entered the public discourse as a concept yet. In the Austrian National Energy and Climate Plan (FMST, 2019), which was sent to Brussels in December 2019, we observe a similar pattern. A number of measures and policies based on the sufficiency principle are included in the report, although not explained as such. On the one hand, the reports are strongly supply-side oriented and, on the other hand, they were written by experienced and informed but politically constrained officials. The NECP mentions measures that seem achievable: the consideration of a CO2 tax in the non-ETS sector and support for multimodal freight centres. The LTS does not mention sufficiency by name, but lists numerous ambitious measures: more durable products, fewer flights, higher car occupancy, less meat consumption and flexible community buildings and housing for young and old people.

In autumn 2019, the new coalition government of conservatives and green party was formed, including a new ministry for "Climate Action, Environment, Energy, Mobility, Innovation and Technology" (Klatzer et al., 2020). In the same year, this ministry published a bioeconomy strategy that names sufficiency as a strategy element. The new government, which started its work in January 2020, after the submission of the NECP to the EU Commission, has not allowed for a stronger orientation towards the sufficiency paradigm. However, the majority opinion of the population could turn in favour of sufficiency in the long term. As part of the Austrian Corona Panel Project, a representative sample of the Austrian population (14 years and older) was asked in August 2020 how they would like to shape their consumption currently and in the future. 7 out of 10 respondents would like to at least partially reduce personal consumption in the future (Riefler, 2020).

4.4. Sectoral distribution

Out of the 230 policy measures found in total, we found 124 in the transport/mobility sector, and with 12 measures total fewest in the buildings sector (see Fig. 2). We classified about 30 percent of sufficiency measures as reduction, 50 percent as substitution-type and about 20 percent as general sufficiency-supporting types (for category explanation see 3.4). In our sectoral and sufficiency-type analysis, four findings are paramount: (1) the heavy overweight of the transport sector, (2) the marginal number in the buildings sector, (3) the very high fraction of "substitution" measures in the transport sector, and (4) the almost exclusive application of "general" among cross-sectional measures. These are measures that generally promote efficiency, consistency or sufficiency strategies (see methods subsection 3.4).

The distribution between sectors and sufficiency types can be largely explained by the following factors:

- **Transport focus:** In our sufficiency definition, we decided to include measures aiming at the reduction of an environmentally harmful technology while promoting more sustainable solutions. This makes modal shift measures which aim to shift road traffic to "slow modes" an public transport (which every country considers) more or less extensively eligible for inclusion as "sufficiency" and leads to a large number of measures within the transport sector.
- **Substitution in transport:** Policy documents have dedicated sections on the transport/mobility sector, with mostly a focus on alternative fuels/e-mobility (not included in the sufficiency definition) and also measures for modal shift to "slow modes" and public/rail transport. Such measures are coded as "substitution". Unlike

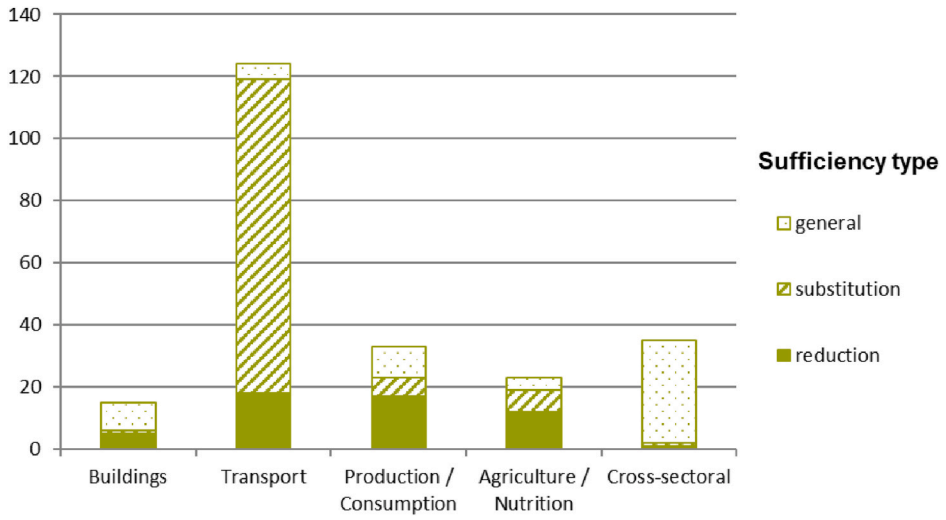

Fig. 2. Number of sufficiency measures by sector and sufficiency type.

other sectors, transport has thus a structurally promoted sufficiency dimension.

- **Lack of sufficiency in building sector:** The measures included in report sections on buildings are highly focused on building efficiency. Measures addressing sufficiency by reduction such as limiting increasing living spaces, revisiting thermal comfort norms, or questioning the proliferation of appliances and gadgets, are rarely found. It seems that either countries assume technological measures to be sufficient to reach the climate targets in this sector or that sufficiency approaches are not considered at all or not as an appropriate strategy to reduce emissions in the building sector.
- **Few reduction-focused sufficiency measures:** Measures that aim at sufficiency through reduction are mostly very specific and within one sector. Contrarily, measures not targeted at one specific sector but applied cross-sectorally are almost exclusively altering the general framework (such as taxation structures) that supports any sufficiency, efficiency or renewables/consistency strategy.

4.5. Instrument types

For this analysis, the types of policy instruments applied within measures are of special interest. Within one measure encountered in the documents, one or more policy instruments can be listed. This multi-instrument use is especially pronounced in the transport sector. As a consequence of multi-instrumentation, the total number of 230 measures covers 281 instruments. We find that all types of instrument categories defined by UNFCCC (2000) are applied for sufficiency policies, although with priorities varying between sectors (see Fig. 3). Of the few building sufficiency policies found, the majority was information campaigns. In the mobility/transport sector, fiscal and economic instruments dominate (this includes infrastructural measures). Production/consumption-sector sufficiency policies are balanced between instrument types, similar as in the agro-food domain. The cross-sectoral measures contain all general framework measures which are mostly economic instruments such as carbon taxes, and other reforms in energy taxation structures. A categorisation of "not specified" may hint at only vague implementation intents. The share of those is highest in the buildings and agriculture sector.

4.6. Synthesis of findings

This section pulls together findings from above and draws additional insights. Fig. 4 presents sufficiency measures found by sector, instrument type and sufficiency type. The bubble size indicates the number of instruments.

The first clear finding is that the largest number of instruments is

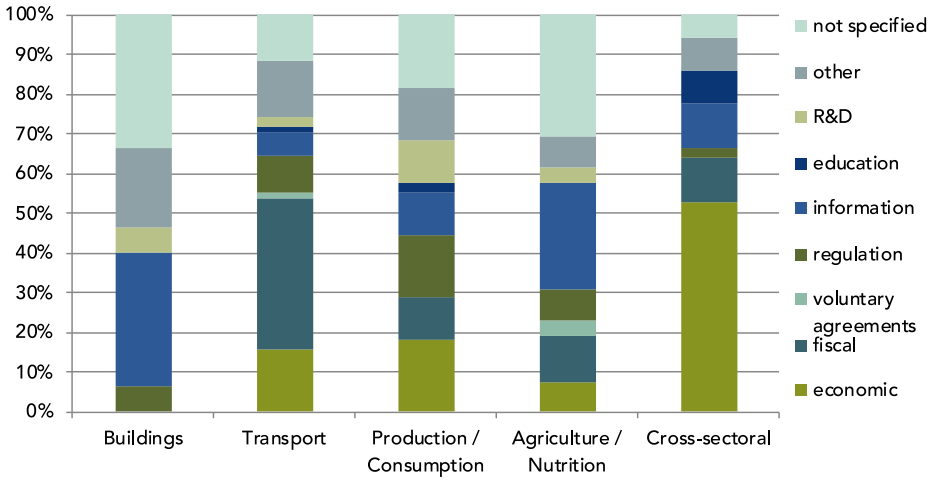

Fig. 3. Number of sufficiency measures by sector and instrument type.

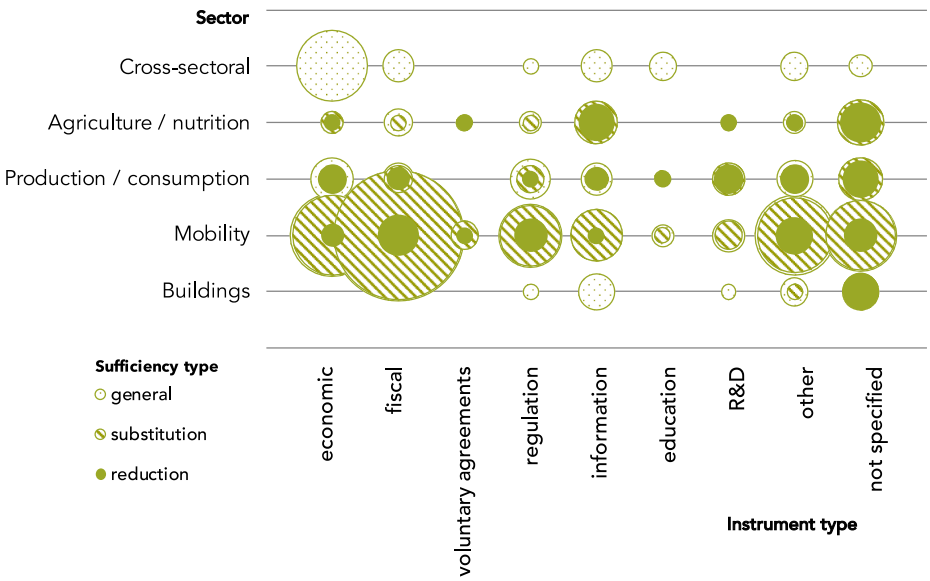

Fig. 4. Number of sufficiency measures by sector and instrument type (for all sufficiency types.

found in the transport/mobility sector, however only a small fraction of these are aiming at reducing services, the largest share is targeted towards substitution, i.e. various types of modal shift measures. Also, a majority of the large number of fiscal measures found in the reports concentrate in the transport sector. As far as sufficiency is concerned, due to our inclusion of modal shift in the sufficiency definition, these relate mostly to investment into rail and cycling infrastructure to improve their attractiveness and promote modal shift.

In the production/consumption sector, we find 8 instruments related to circular economy. These are very diverse, addressing raw materials/resources, forest, or waste. Several are aimed at promoting business models for sharing and longevity of products.

As previously mentioned, the building sector has very few sufficiency policies mentioned. This is somewhat surprising given the relative importance of the sector. A possible explanation is that the state has a more direct responsibility for mobility infrastructures and that interventions in the private building sector, especially following sufficiency strategies, may be perceived as more difficult.

Another finding is that cross-sectoral measures are exclusively of general, supporting nature with a heavy focus on economic instruments, i.e. mostly taxation structure reforms.

To little surprise, governments currently do not foresee a major role of regulatory instruments in the sufficiency policy field (25 of 281, including substitution, and 15 are transport regulations). In addition to previous findings, we see that 20 of in total 64 reduction-oriented sufficiency measures in all sectors have not concretely defined policy instruments. In many instances, these are measures of more intentional or visionary nature, where document authors recognise the need for change but have not defined concrete policy action yet. More generally, we did not find any measures that essentially question the current economic growth paradigm or contradict the dominant social paradigm on consumerism (apart from several proposals of the French Citizen's Convention). It also appears that sufficiency is nowhere considered as a systemic and overall societal transformation strategy that should be applied consistently in all sectors. Most measures we found aim for additions, e.g. of mobility infrastructures, technologies, for changing economic incentive structures or behaviour changes.

In a large number of the analysed documents, the vital need for sufficiency is recognised. Sufficiency is however not an established concept in most documents, it is instead often termed "behavioural change" and subsumed under energy efficiency. Quite representative for many, the latest submitted NECP from Ireland states that "attaining the objective of a low carbon future will involve radically changing behaviour as citizens, industry and Government and becoming significantly more energy efficient" (Department of Communications, 2020, p. 76).

Previous research (e.g. Toulouse et al., 2019) has suggested the need of policies for enabling key sufficiency developments in all sectors: buildings (e.g. reducing per-capita floor areas and less artificial heating/cooling temperatures), transport (reducing especially road and air transport km), and production (fewer and more long-lasting products). However, the described official documents include very few of such measures.

5. Limitations and further research need

Some of the documents analysed are extensive (200+ pages) and the measures must be extracted from continuous text. We therefore only analysed official NECP and LTS documents, but no other detailed national strategies, plans or laws. Our findings are thus limited to published NECP and LTS documents and potentially incomplete if these documents do not cover all national measures, but we provide a first comparative study of sufficiency policy across EU member states.

As explained in section 3, we count sufficiency measures found in countries and the instruments applied. The accounts are however contingent on the level of detail in the primary sources, the level of structure in which they are listed and described and thus how they could be distinguished for our research. The between-country comparison may thus be biased simply by different reporting standards alone. However, assuming that measures are described in a uniform way *within* a country report, we expect the bias of our analysis with regard to the distribution of measures across sectors, the type of sufficiency, and the type of

instrument will be small.[5] While comparison between countries may therefore be problematic, we expect that other analyses are relatively reliable.

Also, the fact that some countries submitted both a NECP and a LTS can lead to a higher number of sufficiency measures simply because the LTS, with a focus on achieving mid-century climate targets, includes measures that are not part of the NECP. We indicate this in Fig. 1 with an asterisk. If measures are mentioned in both reports, they are only counted once in our list of measures.

Some bias may be introduced for Member States who submitted their LTS only after our cut-off date, if their level of ambition in the LTS diverges from NECP. This may be the case e.g. for Spain or Italy.

The analysed NECP and – to a lesser extent – LTS documents follow a prescribed template provided by the EU Commission. The NECP format includes separate chapters on "objectives and targets" and on "policies and measures", each with subsections on the five dimensions 1) Decarbonisation (including Renewables), 2) Energy Efficiency, 3) Energy Security, 4) Internal Energy Market and 5) Research, Innovation and Competitiveness. There is no dedicated section on energy sufficiency, and thus countries are neither motivated to consider the application of such policies, nor urged to report on sufficiency measures they might want to implement. As a consequence, for our analysis, measures had to be extracted from any of the reports' sections.

Although the climate plans submitted to the EU might not cover all sufficiency policies implemented or planned in the member states, we find them to be suitable indicators for the status of sufficiency in relation to efficiency and renewable energies as climate protection strategies. They do reveal on the one side if the concept of using less energy services in absolute terms and favouring very low-energy activities is recognised at all in European countries – it is, but to a minor extent –, and on the other side to assess whether governments consider that downsizing to a level of "enoughness" is happening by itself, or whether it has to be strategically tackled and supported by policy.

Further research is required in this context. Based on our findings, an evaluation or impact assessment of sufficiency policies can help to understand their effectiveness. Furthermore, research on potential interaction effects with efficiency and renewables and possible rebound effects (see Sorrell et al. (2020)) is needed.

It is also important to further analyse the French and Austrian cases (the two most advanced EU Member States according to our research), and to understand how they might inspire other countries to start considering more sufficiency policy options.

In this paper, our research did not extend to understand why some governments were more inclined to consider and report on sufficiency measures (beyond the spotlights on France and Austria), and what the conditions were under which they would do so and publicly advocate such measures in their plans. Research has shown that sufficiency remains controversial, and that the potentials of sufficiency policy sometimes suffer from a perceived lack of plausibility (Dufournet et al., 2019). Sufficiency clearly does not receive the same strong political support as efficiency or consistency do today.

6. Conclusion and policy implications

Previous research has shown the need for policies to enable important developments in sufficiency in all sectors. Such consistent policy packages are rarely found in current policy documents.

We find that sufficiency is seldom mentioned explicitly and rarely seen as a key field for policy action in the climate plans and strategies of European countries, and is often limited to a future hypothetical prospect of personal behavioural change. Relatively few policy measures we find can be regarded as policies to reduce energy service, which are aimed at lowering energy demand levels. Instead, most policies aim at shifting demand towards less energy-intensive services (e.g. transport modal shift). The transport sector seems to be in a sufficiency focus, as we considered modal shift policies to reduce road transport through substitution and thus as sufficiency. The types of instruments of sufficiency policy vary greatly from sector to sector, with an emphasis on e.g. economic and fiscal instruments in the mobility sector, information in the building sector and cross-sectoral application of economic/tax instruments. Regulation currently plays a minor role in sufficiency policy. These findings are subject to a number of limitations discussed in the previous section, including e.g. missing LTSs for some Member States, varying level of detail of the documents, potential language/translation bias and no analysis of efficiency and renewable energy-policies. As explained, we consider the resulting bias as limited. Much future research and policy assessment is however needed: on the relation between sufficiency and other policies, on quantifications and impact assessment, on the empirical and potential future role of the sufficiency policy strategy.

BMK, 2020, energy sufficiency does not seem to be regarded as a central policy strategy for achieving climate targets, as official documents largely focus on efficiency, renewables and mode shift in transport. Given the enormous challenge of decarbonising the energy system and society as a whole by 2050, the consideration of sufficiency actions, together with efficiency and consistency/renewables will most likely be necessary, although further research is needed on interactions between sustainability strategies and their rebound effects. As an analysis for the European Commission showed, the implemented and planned measures of Member States as described in the NECPs will only lead to a reduction of 41 % of the EU's GHG emissions until 2030 EC (2020a). If the EU's GHG target becomes more ambitious, Member States will have to adopt more ambitious climate and energy policies that possibly include more sufficiency. We thus expect some dynamics for the consideration of sufficiency policies within the EU and its Member States in the course of the (anticipated) ambition raising of the EU climate target for the year 2030.

For the implementation of sufficiency, we consider a broad public discussion informed by scientific arguments to be very important. The first indications supporting this are the sufficiency policies recommended by the Citizen Conventions in France and Ireland. Another very important aspect of energy sufficiency policy acceptance and long-lasting effects seems the right framing for this multidimensional sustainability strategy (see e.g. Jensen et al., 2019).

The current space of sufficiency in the policy discourse looks similar to that of energy efficiency before the 2000s: it is sometimes recognised as a necessary trend for the future, but is not yet understood as or even ready to be turned into a field of concrete policy action. Its implementation is still understood to take place through individual changes in behaviour, or through some exogenous societal trends. This falls very much short on the potential and nature of sufficiency: as an integrated and multidimensional concept it challenges current energy policy and societal norms and can lead to new perspectives on how sustainability issues could be solved.

On the contrary, scientists are of the opinion that the diffusion of sufficiency is very much dependent on political support (Schneidewind and Zahrnt, 2013; Kopatz, 2016; Fawcett and Darby, 2019). There is a growing body of literature on how a consistent political framework may look like that enables lower energy service demand levels, making use of all policy instrument types: from economic incentives, investments in alternative infrastructures, education and information, research and development, as well as official prescriptions, rules, and regulations in different sectors.

The key policy finding from our research is that, apart from modal

[5] For example, the German NECP includes a high level of detail on measures, presented in a very structured way. This eases coding procedures and leads to a comparatively high number of encountered measures in DE. However, we are careful to conclude that DE has a higher-than-others sufficiency ambition. Rather, the level of detail leads to more reliable distributions by sector, instrument type and sufficiency type.

shift efforts in the personal mobility sector, sufficiency in the EU is currently poorly backed by concrete short-term policy measures and longer-term plans. This implies an enormous policy challenge to fill this gap in the future. A first step can be its inclusion in reporting templates for European NECPs and LTSs in specific sections. In addition, the EU Commission may e.g. initiate a debate in and between Member States by setting up a dedicated Concerted Action (CA) on sufficiency, which would require an additional legal basis, e.g. as an article in the Energy Efficiency Directive (EED). Additional momentum may also come from more dedicated research, modelling and policy consulting on energy sufficiency policies, e.g. funded through the upcoming Horizon Europe or Life research programmes.

Together with the further specification and development of the NECPs and LTSs, the presence of sufficiency in national plans and in concrete measures should be monitored. For achieving ambitious climate goals and enabling societal change, sufficiency policy needs to step out of the niche and become a genuine field of policy action.

CRediT authorship contribution statement

The work of document content analysis was shared between the authors **Carina Zell-Ziegler, Johannes Thema, Benjamin Best, Frauke Wiese, Jonas Lage and Annika Schmidt**. Each author analysed between 3 and 6 documents in the first round and 0 (maternal leave) to 6 documents in the review round. In addition, they participated to bilateral consolidation meetings and coding harmonisation. These authors thus all contributed to the Investigation, Formal analysis and Validation of the study as well as to the Methodology, and Writing - Review & Editing.

Edouard Toulouse and **Sigrid Stagl** contributed the country case sections on France and Austria (Writing - Review & Editing).

Additional individual contributions include:

Carina Zell-Ziegler: Conceptualization, Methodology, Resources, Writing – original draft, Supervision. **Johannes Thema:** Methodology, Writing – original draft, Visualization, Supervision. **Benjamin Best:** Writing – original draft. **Frauke Wiese:** Conceptualization, Writing – original draft. **Jonas Lage:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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